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INSTRUCTIONS FOR

AC ELECTRONIC VOLTMETER

MODEL 300A

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INSTRUCTIONS FOR

AC ELECTRONIC VOLTMETER

MODEL 300A

1. GENERAL.—This instrument is designed to measure sinusoidal voltages over a range of 1 millivolt to 100 volts. The frequency range extends from approximately 10 cycles to 150,000 cycles. It is intended to be operated from a 110-120 volt 60-cycle power supply. 220-volt models are also available on special order. The scale of voltage is logarithmic over a range of 10 to 1 which permits decade ranges to be used, the whole voltage range being covered by five such decade ranges. The meter also has a uniform decibel scale, numbered from 0 to 20 decibels. In order that the voltmeter may also be used as a flat high-gain amplifier the AC output is made available by means of a jack. Plugging into this jack automatically disconnects the indicating meter. A fine adjustment of the AC output is provided by means of a knob labeled AC OUTPUT CONTROL.

2. GENERAL DESCRIPTION.—The instrument consists essentially of a multi-stage amplifier terminated by a diode rectifier and a meter to indicate the rectified current. This meter is specially designed with shaped pole pieces so that the indications are proportional to the logarithm of the rectified current over a range of 10 to 1. The rectified current is accurately proportional to the input voltage over the working range. A novel feature of the instrument is the linearization of the rectifier action and stabilization of the gain in the whole system which is achieved by bringing back rectified energy to the input circuit. This renders the indications of the instrument substantially independent of variations in line voltage, tubes, circuit components, etc., and makes possible the use of the amplifier-rectifier system as a stable voltmeter.

3. OPERATION.—The instrument is ready to operate as received and it is merely necessary to plug it into the a-c power source and turn on the switch marked ON-OFF. A

pilot light is provided to indicate when power is on. The input terminal marked GND should always be grounded. A one-half ampere fuse is mounted on the chassis inside the case. Spare fuses are provided and if additional fuses are required these may be ordered directly from Littelfuse, Inc., 4757 Ravenswood Avenue, Chicago, Illinois. The type number is 1007. An indication of the blowing of the fuse is the failure of the pilot light to light when the switch is turned on. To renew the fuse first disconnect the instrument from the a-c power line and after removing the four nickel-plated oval head screws on the sides of the panel carefully lift out the panel from the case. Care should be taken not to disturb any of the wires on the chassis.

4. RANGE ADJUSTMENT. — This is a screw-driver adjustment to be made through a hole in the side of the case. Its purpose is to bring the 10 on one range to exactly 1 on the next higher range. This is accomplished by means of an auxiliary voltage which compensates for the contact potential and initial velocities in the diode. Ordinarily no adjustment should be necessary but if some discrepancy is noted the adjustment should be made as follows: Allow the meter to warm up for five minutes. Connect a source of **pure** sinusoidal a-c at 500-5000 cycles to the input. Adjust this so that the meter reads 10 on any range other than the 100 volt range. Switch to the next higher range. The meter should read exactly 1 (within 2%). If not remove the black button at the side of the case and adjust with a screw-driver until the meter reads 1. Switch back to the lower range and check to see that it reads 10. If not readjust the input voltage to 10 and switch back to 1, readjusting with the screw-driver if necessary.

In the past some users of this instrument have misunderstood the purpose of this adjustment and have tried to use it to bring the needle on the meter to 1 on the scale with no voltage connected to the input terminals. The indicating meter has no "zero" as in the case of other more conventional types. The normal position of the needle with no voltage connected to the input is over to the extreme left against the stop and off scale. The meter should read only when the proper voltage is connected to the input.

5. INPUT IMPEDANCE.—The input impedance of the instrument is 500,000 ohms shunted by an effective capacity of about 30 mmfds.

6. OUTPUT IMPEDANCE. — The output impedance at the a-c output jack varies with the setting of the output control, reaching a maximum value of 15,000 ohms when the control is on maximum.

7. OVERLOAD CHARACTERISTICS.—The circuits are so designed that the instrument overloads promptly when the voltage exceeds the full scale indication of the meter, thus protecting the indicating meter. This is of considerable advantage over other types of meters which may be seriously damaged by overloads such as the Model 300 Voltmeter will stand. The maximum voltages which can be safely recommended on each range are as follows:

Range	Max. Voltage	Overload Ratio
.001 — .01	2	200
.01 — .1	20	200
.1 — 1	200	200
1 — 10	700	70
10 — 100	700	7

8. EFFECT OF WAVE FORM.—The indications of this instrument are proportional to the average value of the a-c voltage. The instrument is intended to be used on sinusoidal voltages and the indications are in terms of the r.m.s. value of a sinusoidal wave. The instrument tends inherently to ignore harmonics in the voltage wave and to indicate the value of the fundamental. This is a decided advantage in certain applications, making it possible to use impure sources for measurement purposes. Since a peak reading voltmeter of the diode rectifier type tends to respond to maximum values and a square-law meter of the thermocouple type tends to respond to r.m.s. values, the readings of such meters and the present voltmeter will not agree when harmonics are present. In the case of a third harmonic content of 20% phased for maximum deviation the Model 300 Voltmeter reading will deviate 5%

while the peak reading diode voltmeter will deviate 20% and a r.m.s. instrument will deviate 2½%. The Model 300 Voltmeter will discriminate even more affectively against stray voltages which are not integral multiples of the voltage being measured. For example in the case of stray voltages equal to 20% of the voltage under measurement the Model 300 Voltmeter indications will be 2% high, the r.m.s. voltmeter will be 2½% high and the peak reading voltmeter will be 20% high.

9. MEASUREMENT OF VOLTAGES OVER 100 VOLTS.—Multipliers are available to extend the range of the voltmeter to voltages above 100. The Model 402A Multiplier extends the range by a factor of 10 up to 1,000 volts maximum. This has an input impedance of 4.4 megohms shunted by a capacity of 8-10 mmfds. The Model 402B Multiplier extends the range by a factor of 100 to 10,000 volts and has an input impedance of 44 megohms shunted by 3 mmfds.

10. MEASUREMENT OF VOLTAGES BELOW ONE MILLIVOLT.—When voltages below one millivolt are to be measured we recommend the use of our Model 220 Decade Amplifier. This provides gains of exactly ten times or one hundred times and when placed in front of the Model 300 Voltmeter permits measurements down to about 20 microvolts. The amplifier is battery operated and has about the same input impedance as the voltmeter itself. This instrument is fully described in Bulletin 8.

11. MEASUREMENTS ON HIGH IMPEDANCE CIRCUITS.—It is sometimes desirable in making voltage measurements to have a higher impedance than the 500,000 ohms presented by the Model 300 Voltmeter. Where a sacrifice in sensitivity can be tolerated an increase in impedance may be obtained by using either the 402A or 402B Multipliers with the voltmeter. In this way with the 402A Multiplier (10×) an input impedance of 4.4 megohms shunted by 8 mmfds. is obtained and with the 402B (100×) Multiplier an input impedance of 44 megohms shunted by 3 mmfds. is obtained.

12. **Measurements of 60-Cycle Voltages.**—When measurements are to be made of voltages derived from the same power source used to operate the voltmeter a special precaution is recommended for the most accurate results. The necessity of this is due to the fact that there is a small residual hum pickup from the power transformer which introduces a slight voltage into the input circuit and, depending on its phase with regard to the voltage being measured, may cause a slight error. This error will be maximum near the lower part of the scale and minimum at the upper end. To eliminate the effect it is recommended that two measurements be made, one with the power plug in normal polarity and another with the power plug reversed. The mean of these readings will represent the true value. Since the error should never exceed 2 or 3 percent this procedure will usually not be necessary except where very accurate measurements are desired.

13. **Input Circuit.** — The input circuit is protected from d-c by means of a series condenser of 400 volts rating. If d-c voltages higher than this are applied an auxiliary protective network should be provided. This can consist of a .2 mfd. condenser in series and a 1 megohm resistor in shunt. An example of the use of such a network would be the measurement of commutator ripple on a 600-volt dynamotor.

14. **Servicing.**—Servicing of this instrument by the user is not recommended. The only things that should be attempted are the renewal of the fuse and tubes. If trouble develops it is recommended that it be returned to us for servicing. **Before doing this the trouble should be described to us by letter,** after which shipping instructions will be furnished. In no case should the wires in the instrument be tampered with because the calibration and performance of the instrument depend critically on the position of certain wires.

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